Combining Radar Interferometry and Polarimetry to Estimate Forest Vegetation and Surface Parameters

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Interferometric synthetic aperture radar (INSAR) data are sensitive to the height and vertical characteristics of forests. The dependence of INSAR data on 1) tree height, 2) underlying topography, and 3) extinction coefficient has been derived by modeling the forest as a collection of statistically homogeneous volume scatterers! The derived dependences apply to INSAR for which the data at each end of the baseline were collected simultaneously. It has further been shown that cross-correlation amplitudes and phases from multiple C-band INSAR baselines can be used to estimate the above three parameters. For sparse forests at C-band and for many forests at lower frequencies, ground-trunk and ground returns may contribute substantially to the scattering mechanisms. The additional contribution of scattering centers near the ground, which will lower INSAR cross-correlation amplitudes and phases, will cause errors in estimating the above parameters using only the volume-scattering model. These errors, which can be at the few-meter level for tree height, motivate augmenting the volume-scattering model. Due primarily to the dependence of the reflection coefficient on polarization and incidence angle, ground-trunk and ground returns exhibit a strong polarization dependence. This strong dependence motivates augmenting interferometric data sets with SAR backscattered power at both HH and VV polarization, as well as the amplitude and phase of the cross-correlation between signals of different polarization. Single-polarization INSAR data will be considered, because the TOPSAR system used to acquire data for demonstrations is capable of only VV interferometry.

This paper models the dependence of INSAR and polarimetric data on the above volume-scattering parameters as well as an additional set of parameters relating to ground-trunk and ground characteristics. Additional parameters for which INSAR and polarimetric SAR data depend include the rms surface height, the average reflection coefficient of the ground, the average scattering amplitude of the tree trunks, and the number of tree trunks per unit area. The dependence of the data on these additional parameters will be modeled with Kirchoff scattering for the rough ground surface and finite-height cylinder scattering from the tree trunks. The sensitivity of the INSAR and polarimetric SAR data to the above parameters will be shown. These sensitivities will suggest data acquisition strategies, which will probably involve multi baseline, multifrequency INSAR and multifrequency polarimetric SAR. Data from the BOREAS Southern Study Area in Canada and from OTTER sites in Oregon will be used in limited parameter estimation demonstrations.

REFERENCES:

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